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Efficient Destination Discovery using Geographical Gossiping in MANETs

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***Abstract*— Due to dynamic topology of Mobile ad hoc networks (MANETS), early designs of routing protocols incur a large number of discovery packets while trying to discover a route to a destination node in the network. To reduce the number of discovery packets, geographical information assisted routing protocols came into picture. In case of geographical ad hoc routing protocols, there is no need to discover a route to a destination node. But, they need to discover the fresh location of a destination node to deliver data packets to the destination location. Geographical information assisted ad hoc routing protocols reduce discovery packet overhead using past information about the destination node such as location, velocity and direction of motion. When a source node does not have any information about a destination node, the existing geographical routing protocols use flooding techniques or location database server to know the present location of the destination. A flooding technique or a location database server induces large number of control packets in the network. To reduce the number of control packets during location discovery, we propose a novel geographical gossiping technique for MANETs. The technique basically uses two types of gossiping *viz.* selective and random gossiping. We have evaluated the performance of the proposed technique using qualnet simulator and compared its performance with flooding technique and probability based gossiping technique. The simulation results clearly show that our technique has considerably reduced control packet overhead compared to flooding and probability based gossiping technique.**

***Index Terms*— Ad hoc networks, geographical routing, gossiping, location discovery, flooding**

I. INTRODUCTION

A mobile ad hoc network is different from conventional wired networks in the sense that it does not have a fixed topology due to independent movement of nodes. Besides, it has no centralized control or base station. Due to decentralized nature of the ad hoc network, it is very useful in military and emergency application scenarios like natural disasters. It can also be used during temporary applications for communication such as business conferences, educational group activities in remote areas and entertainment. Along with the usual problems in conventional networks, ad hoc networks have special cases such as environmental interference, heterogeneity, and limited resources like bandwidth, battery power, and signal transmission range of nodes. So routing becomes a challenging task in such a network. Routing is a mechanism to discover and maintain a route, and to deliver data packets from a source to a destination node in efficient and reliable manner. To

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discover and maintain a route and to route data packets from source to destination, a routing protocol is used. So, it is responsibility of a routing protocol to handle dynamic nature of an ad hoc network and use the limited network resources efficiently.

Many routing protocols have been proposed to deal with dynamic nature of MANETs. Many review papers have been published discussing the existing routing protocols [1], [3]. In the review papers, the protocols are mainly classified into three categories, *viz.* proactive, reactive and hybrid. Proactive type of routing protocols maintains topology information of the network all the time, thus uses more network resources. Reactive type of protocols also known as on-demand routing protocols. These protocols do not maintain topology information of the complete network. These protocols discover and maintain the required information only when needed. Hybrid type of protocols uses the combined features of proactive and reactive routing protocols. Many papers have been published evaluating the performance of existing routing protocols [14], [17]. The protocols mainly suffer because of random movement of nodes in the network. To deal with the mobility of the nodes, many geographical information assisted routing protocols have been proposed. Many survey papers have been published discussing the geographical information assisted routing protocols [4], [11]. Geographical information assisted routing protocols use various techniques to minimize control packet overhead during route discovery or location discovery. These protocols essentially utilize the past location, velocity or moving direction of a destination node to reduce the control packets. They usually restrict flooding of discovery packets by limiting discovery to a small zone of the network or using directional flooding. However, flooding techniques are used if geographical information of a destination is not available. The existing geographical and non-geographical routing protocols use large number of control packets during route discovery or destination location discovery. To overcome these problems and to handle dynamic nature of ad hoc networks, we propose novel geographical information based gossiping technique to discover location of a destination node in the network. The technique is composed of two types of gossiping *viz.* selective gossiping and random gossiping. We compare the performance of the proposed technique with flooding and probability based gossiping technique using simulation. The simulation results show that the proposed technique reduces the control packet overhead considerably during location discovery of a destination node.

Rest of the paper is organized as follows. Related work is presented in section II. Proposed geographical gossiping technique is described in section III. Procedure for destination location reply is presented in section IV. Simulation results to compare the performance of the proposed technique with those of other discovery techniques are presented in section V. Conclusions and future work are given in section VI.

II. Related Work

Many routing protocols have been proposed for ad hoc networks. These protocols induce a lot of control packets during route discovery and to handle the dynamic nature of the ad hoc networks. So many techniques have been proposed to reduce the control packets in the network. One of the famous techniques is to use of geographical information of nodes. Many geographical information based routing protocols have been proposed. These protocols use geographical information of nodes during route discovery to a destination node. These protocols assume that each node has a global positioning system (GPS) [9] and is thus able to know its own location and velocity. Latest geographical location of a destination node should be available at a source node at the time of data transmission in order to forward data packets to the destination. In location aided routing LAR [10] protocol, a source node uses old location and velocity of destination to discover a route to the destination by restricting flooding in a small portion of the network. If the source does not have old information of the destination, then it uses flooding in the whole network to discover a path to the destination. DREAM [2] routing protocol uses distance and mobility based technique to disseminate location information of nodes in the network. Each node maintains location information of other nodes in its routing table. The frequency of location update depends upon the velocity of nodes. A fast moving node broadcasts its location information frequently whereas a stationary node does not broadcast until it moves.

Haas *et al.* [7] have proposed a gossip based flooding technique to discover a route for a destination. The gossiping technique in [7] uses probability based packet forwarding in the network. In this technique, a node rebroadcast a received message with some probability p and discards with probability 1-p. This technique reduces flooding overhead in the network depending upon forwarding probability p. Haas *et al.* used the gossiping technique with AODV[15] routing protocol. They have shown that the gossiping technique highly reduces the number of discovery packets compared to flooding technique. The gossiping technique reduces to flooding technique if gossip probability p is 1. In the gossiping technique, transmission of a discovery

message depends on probability p. Drawback of this technique is that the discovery message may die before the discovery of the destination if gossiping probability p is not appropriate.

Li *et al.* [12] have analyzed gossip based routing approach with regional parameters to reduce the number of discovery packets in the network. They analyzed the use of some ellipse shape regions for destination discovery using the source and the destination as foci. Theoretically and by simulation, they have shown how to set forwarding probability based on the region and the network density. Jiang *et al.* [8] have proposed a routing protocol that restricts the forwarding of a discovery packet only to three nodes in directions at 120 degree from the forwarding node during route discovery to a destination node. They use the technique with AODV protocol. Using simulation study, they show that approximately 12.6% control packets get reduced using the directional forwarding technique compared to pure flooding. Lemmon *et al.* [16] have presented a survey of geographic forwarding strategies and geographic routing protocols. Zhang *et al.* [19] have proposed an estimated distance based routing protocol to steer a route discovery in the general direction of a destination node. In this protocol, to estimate the geometric distance between a pair of nodes, the regularity of change in the received signal strength is exploited. They show that this technique can restrict the propagation range of route request packets and thus reduces the routing overhead. Gaba *et al.* [6] presented a self-configuration algorithm for *GOSSIP 3* [7] that allows the protocol to work optimally for any network. Using extensive simulation analysis, they identify the parameters of *GOSSIP 3* that need special configuration for the protocol to perform optimally. Mahmood *et al.* [13] have presented a gossip based routing approach that follows the proactive routing. In their approach, maximum energy as well as the coverage area is used to select a parent node to forward a packet. In the optimal parent selection criterion, only three parent nodes are selected for routing. Fraser *et al.* [4] have presented a survey of existing literature related to geographical routings in wireless ad hoc networks. They discussed various aspects of the geographical routings such as QoS, security, mobility management, and energy efficiency. In geographical routing protocols, old geographical information of a destination node is used to discover a route to the destination or to know latest location of the destination. If a source node knows the latest location information of a destination, then it can forward data packets to the destination using greedy forwarding technique. Drawback of the greedy forwarding technique is that, a data packet may get stuck at an intermediate node if the node is not satisfying the greedy forwarding criteria. The intermediate node is known as void node and area surrounding it is known as void. Many void handling techniques have been proposed in the literature [5].

III. Destination Location Discovery

In this section, we propose a novel geographical gossiping technique to discovery latest location information of a destination node. Destination location discovery process is initiated only if the fresh enough location information of the destination is not available at the source node at the time of the data transmission. In the proposed gossiping technique, a node maintains information about 1-hop neighboring nodes in its routing table. A node inserts/updates neighborhood information in its routing table by receiving periodic locally (1-hop) broadcasted beacon messages from neighboring nodes. Beacons are broadcasted locally to maintain 1-hop connectivity and to avoid flooding in the whole network. Beacon is a connectivity information message that contains *address, location, location-timestamp and velocity* information of the beacon originating node. If a node does not receive continuous two beacons from its existing neighboring node, then the entry of the neighboring node is marked as deactivated. Similarly, for a remote destination node, if communication with it is not alive, then its entry is marked as deactivated after *Information-time-out* period. The entries are stored in the routing table till *Lifetime* period. If a node is stationary, then *Default-lifetime* period is used for its entry. Description of the above used terms for information management is given below.

- *Information-time-out* is the time period after which information about the node should not be used for data routing.
- *Lifetime* period is the time period during which the information about the node can be used to optimize location discovery procedure.
- *Default-lifetime* is the time period during which information of a stationary node is maintained.

We make the following Assumptions during destination location discovery process.

- All nodes in the network are equipped with GPS device
- Clock is synchronized at each node

We denote the coordinates of a node by the term “location” in this paper. In geographical information based routing protocols, a source node uses location information of a destination node to forward data packets to

the destination. If the source node does not have any information or does not have fresh information of the destination and the source wants to send data to the destination, then it uses geographical gossiping technique to find fresh location of the destination. A source node initiates destination location discovery process in the following two cases.

1. It does not have location information of destination node or
2. It has destination location information which is not fresh enough to forward data packets.

A source node uses a location request packet (LocREQ) for the location discovery of a destination node. The source node uses a *Discovery-timeout* period for the initiated LocREQ as in case of AODV. *Discovery-timeout* period is the time for which the source waits for reply about the destination node. A source uses two types of gossiping techniques to discover fresh location information of a destination, *viz.* selective and random gossiping. A *Gossip_flag* is used in the discovery packet to identify or differentiate between the two techniques in the network. These techniques are described in the following sections.

A. Selective Geographical Gossiping Technique

This technique is used when past stale information of a destination node is known to the source node. The source node initiates selective gossiping technique to find fresh location of the destination. The source determines ellipse shape discovery zone assuming source and destination as foci of the ellipse as shown in Fig.1 [18].

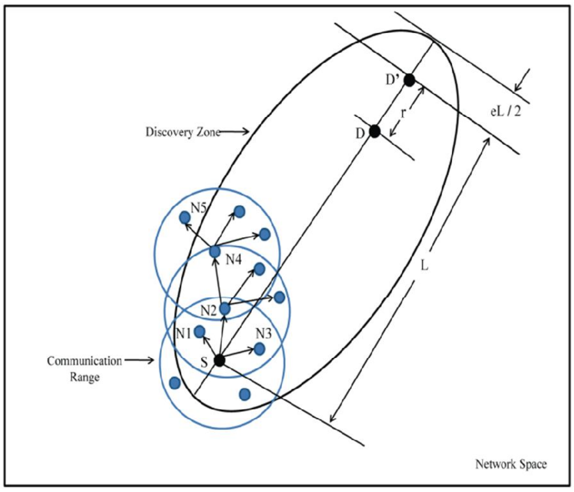

Figure 1. Location discovery using selective geographical gossiping

The source node maintains a monotonically increasing counter for the initiated location request, which is used as *Gossip-id*. Let velocity and location of destination *D* were v_d and (x_D , y_D) respectively at time t_{-1}. At time t_0 , the location of the source S is (x_S, y_S) and it wants to communicate with the destination *D*, but the destination entry in its routing table has become stale. So the source node cannot forward data packets to the accurate location of the destination. Hence, the source initiates selective gossiping to know the fresh location information of the destination as shown in Fig.1. The source calculates the expected displacement of the destination node at time t_0. The expected displacement can be of some distance that is calculated as $r = v_d(t_0 - t_{-1})$. Assuming worst case, the destination moves far away from the source node. In that case, the changed location *D'* of the destination *D* will be approximately taken as $x'_{D'} = x_D + r$ and $y'_{D'} = y_D + r$ instead of $x'_{D'} = x_D + r\cos\theta$ and $y'_{D'} = y_D + r\sin\theta$. Where θ is the angle between the line joining the source and the destination node and past destination location to present location of the destination node. We will call the changed location of the destination as pseudo-location. The geometric distance *L* between source *S* and Destination pseudo-location *D'* can be determine as follows.

$$L = ((x_S - x'_{D'})^2 + (y_S - y'_{D'})^2)^{1/2} \qquad (1)$$

Now, it can be determine, which nodes are inside the discovery zone. Let *d*(*P*, *Q*) represents the distance between node *P* and *Q*. The determined discovery zone includes the set of nodes, say *N*, which meets the following condition.

$$d(S, N) + d(N, D') \leq (1+e)L \qquad (2)$$

Where e $(e \geq 0)$ is the ellipse factor. The area represented by (2) is an ellipse. The size of discovery zone depends upon the ellipse factor. A large value of e will lead to large size of the discovery zone. If $e = \infty$, the discovery zone will be the entire network.

The source node includes following information into a location request packet LocREQ: <*Source-address, Source-velocity, Source-location, Timestamp-of-source- location, Destination-address, Destination-pseudo-location, gossip-id, gossip_flag, hop-count*>

The source node uses distance parameter to do selective gossiping of LocREQ. The source calculates distance between destination and its neighboring nodes using their location information from its routing table. LocREQ is forwarded to the three neighboring nodes which are at minimum distance from the destination node compared to other neighboring nodes. As shown in Fig.1, the source node *S* selects node *N*1, *N*2 and *N*3 to forward LocREQ because these are closer to *D'* compared to other neighboring nodes. If less than three neighboring nodes are available, then the LocREQ is forwarded to the available less than three nodes only. If no neighboring node is available, then the source concludes that the destination is unreachable.

Similarly, an intermediate node follows the same procedure if it does not have fresh location information of the destination. If an intermediate node does not have any neighboring node to forward a LocREQ packet, then it silently discards the LocREQ packet. Only the nodes inside the discovery zone forward LocREQ packets and nodes outside the zone silently discard the discovery packet. In Fig.1, node *N*5 silently discards a received LocREQ packet because it is outside the discovery zone, *i.e.,* it does not satisfy the condition specified in (2). When an intermediate node receives a LocREQ packet, it updates/inserts source information into its routing table before forwarding the request packet. Each intermediate node stores source address and gossip id pair <*srcAddr, gossip_id*> before further forwarding the request packet using selective gossiping. This pair of information is used to avoid redundant forwarding of LocREQ packets and is stored till *Discovery-timeout* period only. If an intermediate node receives the same LocREQ packet again, then it silently discards the LocREQ packet.

If an intermediate node has fresh location information of the destination, then it replies to the source using location reply (LocREP) packet which is described in section IV. If destination discovery fails in the discovery zone, *i.e.,* source node does not get LocREP packet within *Discovery-timeout* period for the initiated LocREQ, then random gossiping technique is used in the whole network to know fresh location of the destination as described in the section III(B).

B. Random Gossiping Technique

This technique is used when source node has no information about a destination or selective gossiping technique has failed. Source node includes following information into LocREQ packet: <*Source-address, Source-velocity, Source-location, Timestamp-of-source-location, Destination-address, Gossip_id, Gossip_flag, hop-count*>

In this technique, a source node randomly selects three nodes from its neighboring nodes and forwards LocREQ only to them as shown in Fig. 2. If the source has less than three neighboring nodes, then LocREQ is forwarded to the available nodes only. If no neighboring node is available, then the source concludes that the destination node is unreachable.

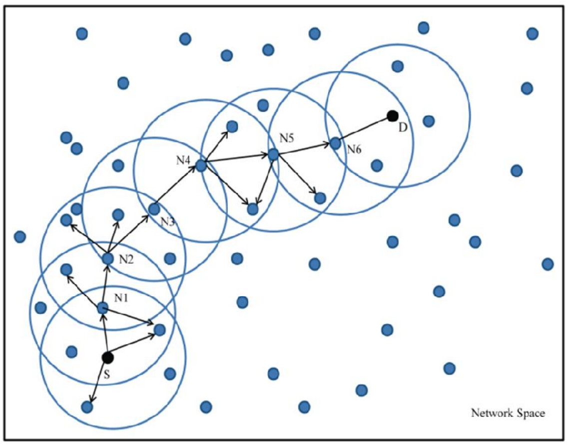

Figure 2. Location discovery using random geographical gossiping

Similarly, an intermediate node also uses the random gossiping technique if it does not have fresh location information of the destination. The intermediate node stores source information in its routing table before forwarding the location request packet (LocREP) as in case of the selective gossiping technique. If the intermediate node does not have any neighboring node to forward the LocREQ packet, then it silently discards the packet. The intermediate node stores the information <*srcAddr, gossip_id*> pair to uniquely identify a LocREQ packet to avoid redundant forwarding of the packets. If an intermediate node receives duplicate LocREQ packet, then it silently discards the packet. As shown in Fig. 2, node *N*1, *N*2, *N*3, *N*4 and *N*5 use random gossiping to flood the request packet in the network. If an intermediate node has fresh location information of the destination, then it replies to the source node using LocREP packet as described in the section IV.

C. Optimizations

There are some optimizations that can be implemented in selective and random gossiping techniques. The optimizations are described as follows.

- Selective Gossiping: The selective gossiping technique uses the stale information of a destination node available at the source node. If the available destination information is very very stale, then it will lead to a large discovery zone. During the selective gossiping, an intermediate node may have more fresh stale information of the destination compared to what was available at the source node. In this case, the intermediate node can redefine the discovery zone for further discovery of the destination location. Obviously, there are some threshold levels for stale information at nodes or indirectly, we can say that the technique uses the optimization limited number of times during location discovery of a destination. Thus the technique can minimize the calculation overhead as well as optimize the location discovery process.
- Random Gossiping: During the random gossiping, it is possible that an intermediate node may have stale information about the destination node. In that case, the technique can switch from random to selective gossiping.

IV. DESTINATION LOCATION REPLY

If a node has fresh location information of the destination for which the LocREQ was initiated, then it replies to the source node using LocREP packet. A LocREP originating node can be an intermediate node or the destination node itself. As shown in Fig. 3, the node *N*6 has fresh location information of the destination *D* and so, it replies to the source node. The intermediate node or the destination node updates source information into its routing table before initiating the location reply to the source.

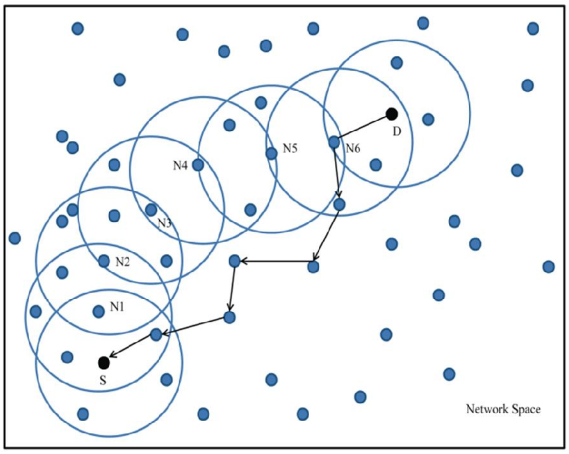

Figure 3. Location reply, independent of the previous discovery path

A LocREP packet contains following information : <*Source-address, Source-location, Destination-address, Destination-velocity, Destination-location, Timestamp-of-destination-location, hop-count*>.

A LocREP packet is forwarded using the greedy forwarding technique. Path of the LocREP packet is independent of the path through which the LocREQ packet was received as shown in Fig. 3. An intermediate node inserts/updates destination information into its routing table before forwarding the LocREP packet

towards the source node. When the source receives LocREP packet, it updates/inserts entry of the destination in its routing table, and then starts data routing.

V. SIMULATION PARAMETERS AND RESULTS

We have simulated our proposed technique using QualNet simulator [16]. We use implementation of AODV[15] routing protocol that is provided in the qualnet simulator to evaluate pure flooding technique for comparison. We use the probability based gossiping technique [7] with the AODV protocol and we named it AODV+G. We Modify the AODV protocol to implement the proposed geographical gossiping technique, and after implementing the geographical gossiping with it, we named it "ad hoc on demand geographical gossiping" (AOGG) protocol. The AOGG protocol does not maintain any path for a source destination pair. It uses greedy forwarding technique using geographical information to forward packets to the destination. We compare the performance of pure flooding (AODV), probability based gossiping (AODV+G) and proposed geographical gossiping (AOGG). We evaluate the three techniques using the following performance metrics.

- Total number of discovery packets: It is the total number of discovery packets used during location/route discovery to a destination node. A discovery packet is sent hop by hop in the network. Each single hop is counted as one transmission and thus one discovery packet.
- Total control packets: This includes route request or location request (RREQ) packet, route reply or location reply (RREP) packet, route error (RERR) packet and Hello/Beacon packet.
- Average hop count per connection: This is the average number of nodes in a route from a source to a destination.

TABLE I. SIMULATION SCENARIO PARAMETERS

Parameter	Value
Simulation run time	1200s
Simulation areas	2000m×2000m
Packet generator application	Super-Application
Packet size	512 bytes
Number of packets from each data source	3000
Mobility model	Random way point
Bandwidth	2Mbps
Node communication range	200m

In the simulation scenario, initially nodes are placed in the $2000m\times2000m$ area network randomly. We use five source destination pairs to generate traffic in the network. Source and destination pairs are selected randomly. A source generates data packets at the rate of 10 packets per second. We use random way point model for mobility of nodes in the network. In this model, a node selects a random point in the network and moves towards it with a random velocity selected from a specified velocity range. After reaching the point, the node becomes stationary till specified pause time period and again moves with different velocity. All nodes use the same procedure during the entire simulation run time. Simulation parameters are shown in table 1.

Simulation parameters for the proposed geographical gossiping (AOGG) are as follows: Beacon Interval = 1s, Discovery Timeout = 2s, Information Timeout = 6s, Default life time = 10s and Ellipse factor (e) = 1.2.

Comparison and analysis of the simulation results of the three techniques are given below.

Simulation results for the total number of discovery packets with number of nodes varying from 100 to 300 at the velocity of nodes in the range [0 10] m/s and pause time of 200 second is shown in Fig. 4. This metric shows direct effect of the proposed technique for destination discovery. From Fig. 4, we can see that discovery packets increase with increasing number of nodes in the network because when a node forwards a request packet, there are more nodes receiving and forwarding the discovery packet. In pure flooding, there is no rule to restrict the propagation of the discovery packets. In probability based gossiping technique, flooding of a discovery packet is restricted using probability based forwarding concept. A node forwards a received discovery packet with some probability p ($p\leq 1$). In the simulation, we use the forwarding probabilities for which the probability based gossiping technique was able to discover the routes for almost all source

destination pairs. In geographical gossiping technique, only three neighboring nodes are selected randomly or conditionally as discussed in section III. Therefore, flooding of the discovery packets is restricted to only three nodes. From simulation, we observe that on the average, the geographical gossiping reduces discovery packet overhead by about 39.7% compared to pure flooding and about 23.6% compared to probability based gossiping technique.

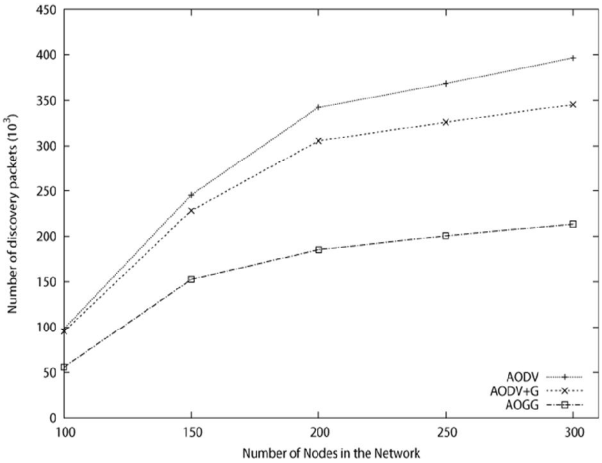

Figure 4. Total discovery packet overhead with number of nodes

Simulation results for total number of control packets induced by the three techniques in the network are shown in Fig.5. As we have mentioned earlier, the total control packets metric includes, route/location request packets, route/location reply packets, route error packets and hello/beacon packets. The figure shows that AOGG performs well although it has an extra overhead of hello beacons. It reduces much discovery packets. Thus AOGG is able to reduce the total number of control packets. On the average, AOGG reduce the control packets overhead by about 36.3% compared to AODV and about 22.4% compared to AODV+G.

Simulation results for total number of discovery packets induced when velocity of nodes varies from 0 to 10 m/s and the pause time is 200s and the number of nodes is kept at 200 are shown in Fig. 6. The results show that discovery packets increase with increasing velocity of nodes. Due to increased velocity of nodes, paths break rate increases, which is responsible for increased number of path discovery packets in the network. Geographical gossiping technique is not affected much with increasing velocity of nodes because it does not discover and maintain path for a source destination pair. It uses geographical forwarding of discovery packet to discover location of a destination node. From simulation study we observe that on the average, the AOGG reduces discovery packets by about 56.8% compared to AODV and by 37.5% compared to the AODV+G.

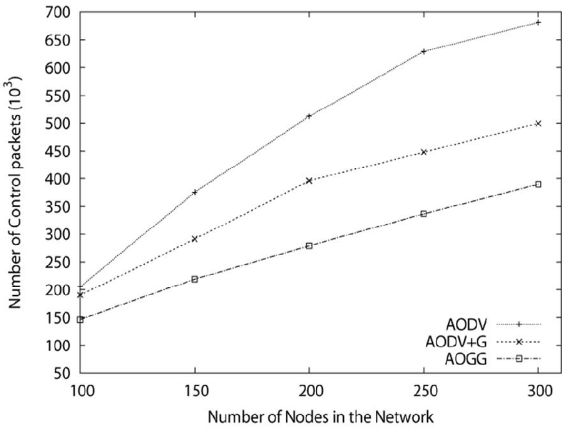

Figure 5. Total control packet overhead with number of nodes

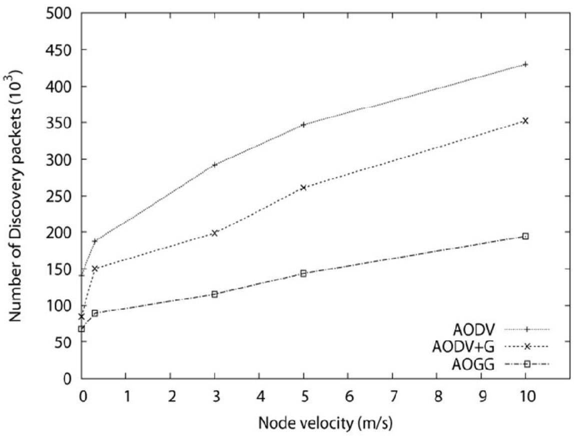

Figure 6. Total discovery packet overhead with velocity of nodes

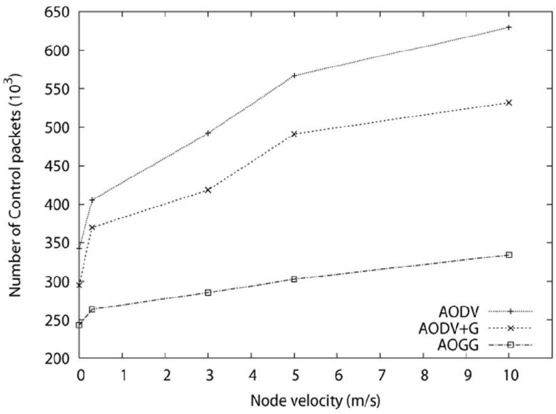

Figure 7. Total control packet overhead with velocity of nodes

Simulation results for total number of control packets induced when velocity of nodes varies from 0 to 10 m/s and the pause time is 200s and the number of nodes is kept at 200 are shown in Fig. 7. AODV and AODV+G maintain path for a source destination pair in the network. Due to increased velocity of nodes, network topology frequently changes that increases paths break, thus much increment in control packets. From simulation, we observe that on the average, AOGG reduce the control packets by about 44.8% compared to AODV and about 32.6% compared to AODV+G.

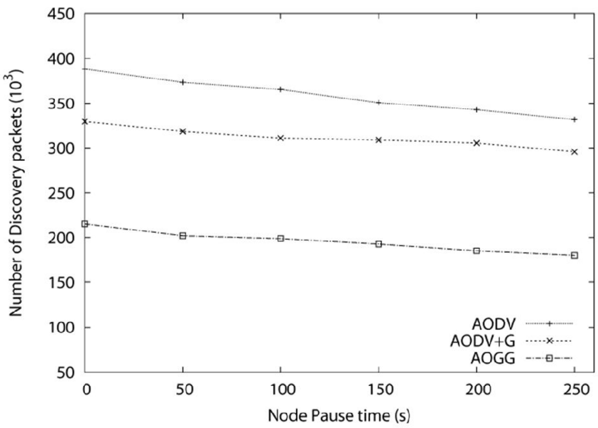

Figure 8. Total discovery packet overhead with pause time of mobile nodes

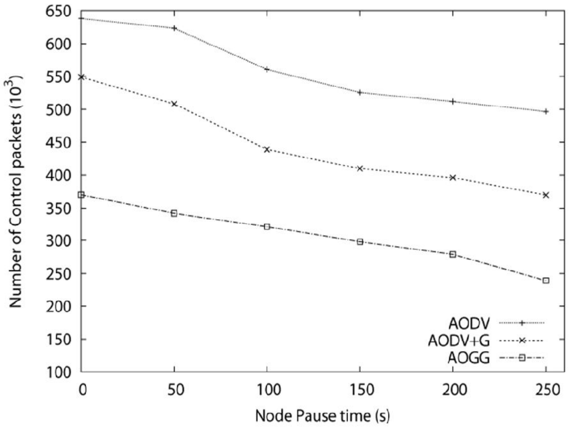

Figure 9. Total control packet overhead with pause time of mobile nodes

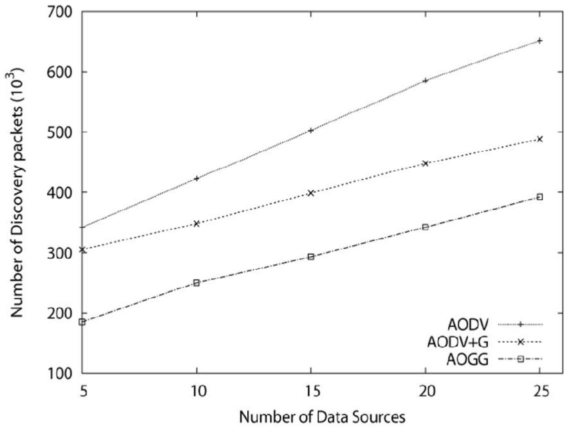

Figure 10. Total discovery packet overhead with number of data sources

Simulation results for total number of discovery packet overhead with pause time varying from 50 to 250 seconds, and velocity of nodes in the range [0 10] m/s are shown in Fig. 8. In this case, number of nodes are 200 in the network. The results show that with increasing pause time of mobile nodes, discovery packet overhead is reduced because with increasing pause time, stability increases in the network topology. From simulation results we observe that on the average, the geographical gossiping reduces discovery packets overhead by about 45.2% compared to pure flooding and about 36.6% compared to probability based gossiping technique.

Simulation results for total control packet overhead with pause time varying from 50 to 250 seconds, and velocity of nodes in the range [0 10] m/s and number of nodes at 200 are shown in Fig. 9. The result follows the same trend as in Fig. 8. Control packets reduce with increasing pause time of mobile nodes. We observe from simulation result that on the average, AOGG reduces the control packets by about 43.7% compared to AODV and about 30.5% compared to AODV+G.

Simulation results for total number of discovery packets with varying number of data sources from 5 to 25, velocity of nodes in the range [0 10] m/s, pause time of 200 second and number of nodes at 200 are shown in Fig. 10. With increasing number of data sources, number of discovery packets increase because there is need to discover more route/location to destinations for data transmission. From Fig. 10, we can observe that the geographical gossiping technique outperforms pure flooding and probability based gossiping technique. On the average, the geographical gossiping reduces the discovery packets overhead by about 41.2% compared to pure flooding and about 22.6% compared to probability based gossiping technique.

Simulation results for total number of control packets with varying number of data sources from 5 to 25, velocity of nodes in the range [0 10] m/s, pause time of 200 second and number of nodes at 200 in the network are shown in Fig. 11. We see that the number of control packets increase with increasing number of

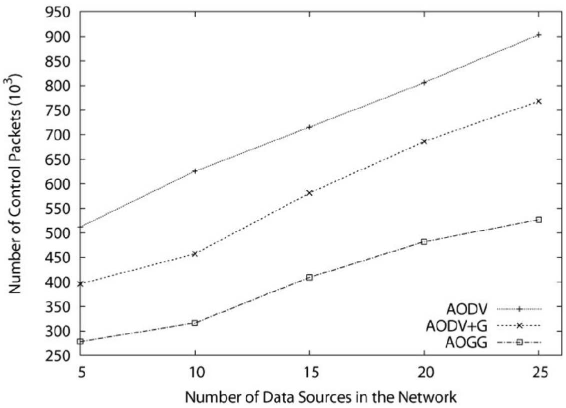

Figure 11. Total control packet overhead with number of data sources

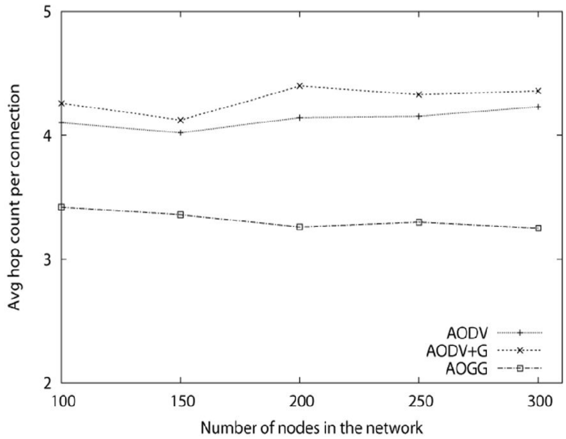

Figure 12. Average hop count per connection

data sources. The rate of growth of control packets in case of AOGG is very less compared to AODV and AODV+G. We observe from the results that on the average, AOGG reduces the control packets by about 42.4% compared to AODV and about 29.9% compared to AODV+G.

Simulation results for average hop count per connection with number of nodes varying from 100 to 300 with velocity of nodes in the range [0 10] m/s and pause time of 200s are shown in Fig. 12. From the figure, we can see that AOGG takes the shortest path to discover location of a destination node. AODV+G slightly increases a route length from a source to a destination compared to AODV because the AODV+G can sometime drop a discovery packet which can take a shortest path.

VI. Conclusions And Future Work

We have presented a geographical gossiping technique for mobile ad hoc networks to discover present location of a destination node in the network. The technique uses two types of gossiping techniques, *viz.* selective and random gossiping. Using simulation, we have evaluated the performance of the proposed technique. The technique greatly reduces the number of discovery packets and control packets compared to pure flooding and probability based gossiping technique.

We have simulated the geographical gossiping with some fixed parameters. We can investigate the performance of the geographical gossiping technique with different parameters and various scenarios. We can investigate the effect of the ellipse factor *e* on the performance of the geographical gossiping technique. Many greedy forwarding failure recovery techniques are available in the literature [5]. We can use one of these mechanisms that would not increase control packet overhead significantly and would provide a guaranteed recovery from the failure.

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